Message Text

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FOR OES FROM HULM

PASS DE FLEUR, ERDA

E.O. 11652: N/A
TAGS: TECH
SUBJ: CRACKS IN PIPING OF BOILING WATER REACTORS

HAVE RECEIVED FOLLOWING COMMENTS ON MECHANISM OF CRACKING OF STAINLESS STEEL IN BWR APPLICATIONS FROM DR. W. MARSHALL, DIRECTOR OF ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL:
QUOTE. THANK YOU FOR YOUR LETTER OF 3RD FEBRUARY AND THE ENCLOSURES ON THE RECENT CRACKS FOUND IN BWR COMPONENTS. CRACKING OF STAINLESS STEEL UNDER BWR CONDITIONS HAS BEEN REPORTED FULLY IN THE SCIENTIFIC LITERATURE BY VARIOUS AMERICAN WORKERS OVER THE LAST 1-2 YEARS. THE CRACKING GENERALLY FOLLOWS AN INTERGRANULAR PATH BETWEEN THE METAL GRAINS OF THE STEEL. VARIOUS FACTORS ENHANCE FAILURE, IN PARTICULAR A HIGH STRESS NEAR THE YIELD POINT OF THE STEEL SUCH AS MIGHT OCCUR AT NOZZLES, HIGH INTERNAL STRESSES PRODUCED IN FABRICATION, SENSITIZATION OF THE STEEL WITH THE FORMATION OF CHROMIUM CARBIDE PARTICLES AT METAL GRAIN BOUNDARIES, AND FREE OXYGEN TOGETHER WITH OTHER CONTAMINANTS SUCH AS CHLORIDE IONS IN THE ENVIRONMENT. THESE FACTORS INTERACT ON ONE ANOTHER TO GOVERN CRACK PROPAGATION RATES AND THRESHOLD CONDITIONS FOR CRACKING.
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THE WIDESPREAD USE OF 304 STEEL IN WHICH THE CARBON

IS FREE TO SENSITIZE THE STEEL DURING VARIOUS HEAT
TREATMENT PROCEDURES INCREASES SIGNIFICANTLY THE
PROBABILITY OF CRACKING IN BWRS. WELDS ARE PARTICULARLY
SUSCEPTIBLE AS WELDING PRODUCES RESIDUAL STRESSES
AND HEAT TREATMENTS OF THE NEIGHBORING METAL WHICH
LEADS TO SENSITIZATION. THE 316 STEEL CAN ALSO BE
READILY SENSITIZED ALTHOUGH IT IS NOT QUITE SO
SUSCEPTIBLE DUE TO THE REPLACEMENT OF SOME CHROMIUM IN
THE CARBIDE PHASE BY MOLYBDENUM. THE PUBLISHED LITERA-
TURE ON CRACKING REFERS PRIMARILY TO THE 304 STEEL DUE
TO THE MORE WIDESPREAD USE OF THIS STEEL. THE PROBLEM
COULD BE CONSIDERABLY ALLEVIATED BY THE USE OF STABILIZED
STEELS IN WHICH THE CARBON IS BOUND TO TITANIUM OR
NIOBIUM IN THE FORM OF THEIR CARBIDES ALTHOUGH THIS
MOVE MIGHT NOT ELIMINATE ALL CRACKING. GENERAL
ELECTRIC APPEAR TO BE RESISTING A CHANGE TO STABILIZED
STEELS FOR REASONS WHICH ARE NOT CLEAR. THIS TYPE OF
CRACKING IS, OF COURSE, NOT OBTAINED IN PWRS DUE TO THE
ABSENCE OF FREE OXYGEN IN THE WATER OF THESE REACTORS.
IF THE RECENT CRACKS PROVE TO BE TRANSGRANULAR, THEY
COULD BE TYPICAL OF STRESS CORROSION PROCESSES ARISING
IN A WIDE RANGE OF NON-NUCLEAR SITUATIONS DUE TO THE
PRESENCE OF APPRECIABLE LEVELS OF CHLORIDE IONS AS WELL
AS OF OXYGEN IN THE ENVIRONMENT. ALTERNATIVELY, FATIGUE
PROCESSES MIGHT BE SIGNIFICANT AS IN THE CORROSION
FATIGUE OF PRESSURE VESSEL STEELS.
IT IS UNLIKELY WE CAN OFFER ANY INFORMATION OVER AND
WHILST THE FAILURES APPEAR TO FALL WITHIN THE EXPERIENCE
SUMMARIZED ABOVE, THE SUBJECT OF CORROSION IS SO DIVERSE
WITH NEW FAILURE MECHANISMS ARISING AT REGULAR INTERVALS,
THAT DEPARTURES FROM THE EXPECTED BEHAVIOR CANNOT BE
DISCOUNTED. SUCH DEPARTURE WOULD NATURALLY BE OF
CONSIDERABLE INTEREST TO US IN THE UK, PARTICULARLY IF
THERE IS A MAJOR TRANSGRANULAR ELEMENT IN THE CRACKING.
COULD I THEREFORE PLEASE ASK YOU TO INFORM US IF ANY
SUCH DEVELOPMENTS ARISE IN THE INVESTIGATIONS ON THESE
FAILURES. UNQUOTE.
PLEASE NOTE DR. MARSHALL'S SPECIAL INTEREST IN THE
SUBJECT AND DESIRE FOR ANY AVAILABLE BASIC INFORMATION
OBTAINED FROM INVESTIGATION OF BWR PIPING FAILURES.
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